Timetable of Mk 47 Events

1/9/57 Assistant Secretary of Defense notifies the United States Atomic Energy Commission that the Navy is developing the POLARIS missile, and requests cooperation in a joint feasibility study of appropriate warheads.

5/27/57 Feasibility study issued, reporting that a suitable thermonuclear warhead could be provided through normal development of designs scheduled for test.

(b)(1), (b)(3)

11/22/57 Division of Military Application requests acceleration of the XW-47 program to meet an operational availability date of December 1959 with emergency-capability warheads.

(b)(1), (b)(3)

1/28/58 Military characteristics of the POLARIS warhead approved by the Military Liaison Committee.

(b)(1), (b)(3)

3/6/58 Sandia forwards development-program definition of the XW-47 Warhead to the Albuquerque Operations Office.

10/6/61 Field Command notifies Sandia that Final Evaluation Report of the Mk 47 Warhead has been accepted by the Services.

(b)(1), (b)(3)

11/62 Mk 47Y2 Mod 2 released for production.

(b)(1), (b)(3)

2/27/63 Mk 47Y2 Mod 2 achieves production.

7/64 Mk 47 Warhead production completed.

(b)(3)

History of the Mk 47 Warhead

The Chief of Naval Operations wrote to the United States Atomic Energy Commission, September 14, 1956, noting that work was proceeding on a Fleet Ballistic Missile powered by solid propellant. Calculations had indicated that if a suitable warhead with a weight of 600 pounds could be produced, the missile could be considerably reduced in size. A smaller missile would offer both operational and logistic advantages to Fleet employment and would permit improvements in missile design. (b)(1), (b)(3)

The Assistant Secretary of Defense notified the Atomic Energy Commission January 9, 1957, that the Department of the Navy was developing the POLARIS, a sea-based, surface-to-surface ballistic missile for use against land targets. The Atomic Energy Commission was requested to cooperate with the Navy and the Armed Forces Special Weapons Project in a joint feasibility study of a warhead for this missile.

The POLARIS, a submarine-launched, two-stage solid-propellant rocket with inertial guidance, would have a diameter of 5 feet, length of 28 feet, gross takeoff weight of 33,000 pounds, and a range from 1,200 to 1,500 nautical miles. The warhead would be carried in the nose cone, and the nuclear device could weigh up to 600 pounds. (b)(1), (b)(3)

It was noted that the warhead parameters were relatively stringent, but that the Navy would accept an interim warhead with a smaller yield. It was felt that the warhead would have to be integrated with the nose cone to properly meet design objectives.[2]

Both the Los Alamos Scientific Laboratory and the University of California Radiation Laboratory were requested to participate in the study, but the major effort was provided by the Radiation Laboratory.[3] A feasibility study report was released May 27, 1957, which stated that no currently stockpiled warhead was adaptable to POLARIS, but that straightforward development of devices planned for future tests should provide a suitable thermonuclear design. (b)(1), (b)(3)

The Navy was designated cognizant agent for the Department of Defense, with normal Armed Forces Special Weapons Project relationships.[5]

A POLARIS Re-entry Body Coordinating Committee was formed and held its first meeting July 29, 1957. It was noted that the re-entry body would include an aerodynamic cone, heat sink, warhead, adaption kit, and attitude controls. The total re-entry body weight, including warhead, would not exceed 835 pounds.
(b)(1), (b)(3)

(b)(1), (b)(3)

The Division of Military Application sent a teletype to the Radiation Laboratory November 22, 1957, noting that the Department of Defense had requested that the POLARIS warhead design, which had been assigned a nomenclature of XW-47, be accelerated to provide a small number of emergency-capability warheads by December 1959.[8]

The Radiation Laboratory replied November 25, 1957, stating that the date could be met. The emergency capability item might be quite different in design than the production version, and the term "small number" would have to be defined, but no major interference with other programs was anticipated. (b)(1), (b)(3)

(b)(3)

(b)(1), (b)(3)

Sandia notified the Division of Military Application December 23, 1957 that the requested acceleration of the XW-47/POLARIS schedule would not affect other Sandia weapon schedules, but that the time interval between design release and early production of the warhead was far shorter than normally provided. The first warhead flight test was scheduled for August 1959, and design release would have to be made by December 1959 to provide emergency-capability units by October 1960. Since only six warhead flights would be completed by the end of 1959, not much design confidence would have been developed. Sandia noted that if the missile flight-test schedule slipped, conditional releases might be required, and hardware delivered without certification as to Mark quality. Subsequently, these items would be certified or replaced.[11]

The military characteristics for the POLARIS warhead were approved by the Military Liaison Committee January 28, 1958. The warhead would be capable of receiving and obeying electrical signals to accomplish the following: Electrical system arming, nuclear system unsafing (if applicable), boosting (if applicable), and firing. (b)(3)

Unless significant gains could be realized by permanent emplacement of all warhead elements, it was desired that safety during storage be guaranteed by removal of a warhead element vital to the operation of the firing system. Before the warhead was installed in the missile re-entry body, a continuous visual indication of the weapon's armed or safed condition was required. After the warhead had been installed, warhead-derived electrical indications would signal the armed or safed condition of the warhead.

The warhead would be nuclearly safe, both individually and in groups, should the storage area become flooded with seawater; while the weapon was being stored or transported in accordance with prescribed procedures; while being carried on missions in readiness for use; or when jettisoned in deep water. The following priorities would be observed: Safety from nuclear disaster to friendly installations, acceptable reliability, invulnerability to neutron radiation, and invulnerability to other environmental conditions.[12]

Plans for evaluating performance of the contact fuze were discussed in a February 7, 1958 subgroup meeting of the POLARIS Coordinating Committee. Rocket sled tests were scheduled, and a model of the re-entry body nose would be impacted against a variety of surfaces. Sandia was requested to design and fabricate the sled, provide a rocket motor, install instrumentation, and conduct tests on the Sandia sled rrack.[13]

(b)(1), (b)(3)

Sandia forwarded the development program definition of the XW-47 to Albuquerque Operations Office March 6, 1958. (b)(1), (b)(3)

The firing set would contain an environmental safety switch, neutron generators, X-unit, chopper-converters and firing circuits, and would be sealed as an entity at assembly. The firing set would then be mated to the warhead and subsequently require only continuity and humidity testing. (b)(1), (b)(3)

The missile would be powered by a polyurethane solid-type propellant.[15]

Sandia wrote to the Navy Bureau of Ordnance March 10, 1958, accepting development responsibility for the contact fuze. It was intended that piezoelectric crystals be attached directly to the missile heat shield and that, in order to keep the thickness of this shield to a minimum, it might be necessary to partially or fully embed the crystals in the heat-shield material. A frangible grid network would be developed as a backup design.

Development testing would be performed in four phases. In the first, a 75mm howitzer would fire projectiles into a simple metal target on which crystal elements had been mounted, and these tests would determine the diameter and thickness of the crystals. In the second series of tests, a 4-inch air gun would fire projectiles into a target simulating a section of the heat shield containing the crystals, and the heat shield subjected to a heat pulse duplicating re-entry temperature. In the third phase, sleds would be fired at different angles into targets of differing hardness. The last phase would call for drop tests of prototype weapons released from aircraft.[16]

Application of the XW-47 Warhead to the BOMARC missile was suggested in a Division of Military Application letter of May 9, 1958, and some design studies were made.[17] However, the application was subsequently canceled August 7, 1958.[18]

The Assistant Secretary of Defense informed the Atomic Energy Commission May 28, 1958, that progress in the POLARIS missile system warranted acceleration of the

(b)(1), (b)(3)

The Special Weapons Development Board met October 15, 1958 and reviewed Report SC4801(TR), Proposed Ordnance Characteristics of the XW-47 Warhead.[26] This report described the warhead and its application to the POLARIS missile. Design objectives and criteria were noted, and warhead compatibility, support equipment, and the test program were discussed.[27] The report was subsequently approved and forwarded to the Division of Military Application.

(b)(1), (b)(3)

(b)(1), (b)(3)

(b)(3)

Another approach was to mechanically safe the weapon, although this would result in a complex design.[26]

The Atomic Energy Commission increased the priority for the XW-47 Warhead November 25, 1958, thus assigning this design top priority.[18] Testing continued throughout most of 1959, with successful salt, rain, sand and dust tests being conducted. (b)(3)

Vibration tests were similarly successful, with no damage being experienced.[29] Centrifuge tests produced minor damage, and necessitated minor redesign.[30] All components were design released by December 1959.

Subsequently, a program slowdown was instituted in January 1960, with the delivery date of the first production warheads being delayed to June 1960 at Navy request. (b)(3)

Mark-quality units were provided by Sandia on schedule.[31]

Field Command notified Sandia May 13, 1960 that Report SC4815(WD), Description and Status at Design Release of the XW-47 Warhead, had been reviewed in coordination with representatives of the three Services. The review established that the design met all requirements, except two, of the military characteristics.
(b)(1), (b)(3)

(b)(1), (b)(3)

A proposal to change the design was approved in December 1960, and resulted in the Mk 47 Mod 1 Warhead, the first production unit of which was delivered in May 1961.[37,38] The Mod 1 Warhead could not be stored at a temperature lower than -15°F, as compared to a desired figure of -65°F, but the Navy was willing to accept this limitation. Mk 47 Mod 0 production was phased out in November 1961, and replaced by the Mk 47 Mod 1.

(b)(1), (b)(3)

(b)(1), (b)(3)

Sandia had notified the Division of Military Application March 8, 1962, that pilot-production items from final tooling would normally be evaluated for design conformance, and then tested with other parts of the system under simulated extreme environmental conditions of temperature, vibration and shock, in addition to flight tests to confirm operation under combined environments that could not always be successfully duplicated in the laboratory. This practice had not been followed in the case of the Mk 47 Warhead, since production started before warhead flight tests were conducted. (b)(1), (b)(3)

Glossary of Mk 47 Terms

(b)(3)

<u>Barometric Fuzing</u> -- Use of a pressure switch actuated by increasing air pressure as the weapon falls in its trajectory to institute weapon fuzing.

<u>Boosting</u> -- The technique of increasing the yield of a nuclear device by introducing deuterium-tritium gas into the implosion process to increase fission activity.

<u>Chopper-Converter</u> -- A device for transforming steady direct current into chopped pulses of energy.

<u>Contact Fuze</u> -- A fuze that detonates the weapon by contact with the ground or the target.

(b)(1), (b)(3)

<u>Field Command</u> -- The local office of the Armed Forces Special Weapons Project (Defense Atomic Support Agency), located on Sandia Base, Albuquerque, New Mexico.

(b)(1), (b)(3)

Kiloton -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is equivalent to the detonation effect of 1000 tons of high explosive.

Lawrence Radiation Laboratory -- A nuclear design organization located at Livermore, California.

(b)(1), (b)(3)

(b)(1), (b)(3)

(b)(1), (b)(3)

<u>Re-entry Vehicle</u> -- That part of a ballistic missile that forms the nose of the missile, generally contains the warhead, and is detached from the missile during the trajectory to re-enter the earth's atmosphere and follow a ballistic trajectory toward the target.

(b)(1), (b)(3)

<u>Thermonuclear</u> -- Two-stage reaction, with a fission device exploding and starting a fusion reaction in light elements.

<u>Ton (Yield)</u> -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-ton yield is equivalent to the detonation effect of 2000 pounds of high explosive.

<u>Tritium</u> -- The hydrogen isotope of mass number 3.

<u>University of California Radiation Laboratory</u> -- A laboratory established at Livermore, California. Initially founded for work on thermonuclear designs.

<u>Uranium-235</u> -- A radioactive element, an isotope of uranium-238.

<u>Uranium-238</u> -- A radioactive element, atomic number 92. Natural uranium contains about 99.3-percent uranium-238; the rest is uranium-235.

<u>Warhead</u> -- A weapon carried to the target by missile.

<u>X-Unit</u> -- A device used to provide high voltage to the weapon detonators.

References

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(b)(3)

2. SRD Ltr, Assistant Secretary for Defense to United States Atomic Energy Commission, dtd 1/9/57. AEC Files, MRA-5, POLARIS, 7/56.

3. SRD Ltr, Division of Military Application to Albuquerque Operations Office, dtd 3/22/57, subject, Feasibility Study of the Nuclear Warhead for POLARIS. AEC Files, MRA-5, POLARIS, 7/56.

4.

(b)(3)

5. SRD Ltr, RS 8232/991, Assistant Secretary of Defense to United States Atomic Energy Commission, dtd 7/3/57. SC Central Technical Files, XW-47, 1-1, Livermore.

6.

(b)(3)

7.

8. SRD TWX, Division of Military Application to University of California Radiation Laboratory, dtd 11/22/57. AEC Files, MRA-5, XW-47, 7/57.

9.

10.

(b)(3)

11. SRD TWX, RS 1/1072, Sandia Corporation to Division of Military Application, dtd 12/23/57. SC Central Technical Files, XW-47, POLARIS.

12. SRD Report, RS 3466/82060, Sandia Corporation to Distribution, dtd 1/28/58, subject, Military Characteristics for a Warhead for the POLARIS Missile. SC Central Technical Files, 47 Program, 1-6.

13. SRD Minutes, POLARIS Re-entry Body Coordinating Committee to Distribution, dtd 2/7/58, subject, Meeting of the Joint Test Group of the POLARIS Re-entry Body Coordinating Committee. AEC Files, MRA-5, POLARIS, 7/56.

14.

(b)(3)

15. SRD Ltr, RS 8000/13, Sandia-Livermore to Albuquerque Operations Office, dtd 3/6/58, subject, Development Program Definition, XW-47. SC Central Technical Files, 47 Program, 1958.

16. CRD Ltr, Sandia-Livermore to Bureau of Ordnance, dtd 3/10/58, subject, XW-47 Contact Fuzing. SC Central Technical Files, 47 Program, 1958.

17. SRD Ltr, Division of Military Application to Albuquerque Operations Office, dtd 5/9/58, subject, Adaption of XW-47 for the BOMARC Application. AEC Files, MRA-5, XW-47, 7/57.

18. SRD Ltr, Field Command to Defense Atomic Support Agency, dtd 2/23/61, subject, Documented History of a Typical Warhead Development, XW-47/POLARIS. Air Force Special Weapons Center Files, Kirtland Air Force Base.

19.

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20. SRD TWX, Division of Military Application to University of California Radiation Laboratory, dtd 3/25/58. AEC Files, MRA-5, XW-47, 7/57.

21. SRD Ltr, University of California Radiation Laboratory to Division of Military Application, dtd 4/15/58. AEC Files, MRA-5, POLARIS, 7/56.

22. SRD Ltr, RS 1/1130, Sandia Corporation of Division of Military Application, dtd 5/29/58, subject, XW-47. SC Central Technical Files, 47 Program, 1958.

23. SRD Ltr, RS 8000/19, Sandia-Livermore to Division of Military Application, dtd 6/18/58, subject, Military Characteristics for XW-47. SC Central Technical Files, 47 Program, 1-6.

24. CRD Amendment to the Military Characteristics for a Warhead for the POLARIS Missile, dtd 7/1/58. SC Central Technical Files, 47 Program, 1-6.

25.

(b)(3)

38. SRD Major Assembly Release, RS 8000/156, Sandia-Livermore to Distribution, dtd 6/21/61, subject, Mk 47 Mod 1 Warhead. SC Central Technical Files, Mk 47 Mod 1 Warhead, General.

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